Table 30

PRECIPITATION CHARACTERISTICS
AT THE CITY OF WAUKESHA: 1940-1987

Month	Average Total Precipitation[a]	Average Snow and Sleet[b]
January	1.5	11.3
February	1.2	7.1
March	2.4	9.6
April	3.1	1.6
May	3.3	0.2
June	3.7	0.0
July	3.5	0.0
August	3.6	0.0
September	3.3	0.0
October	2.3	0.0
November	2.3	2.9
December	1.8	8.6
Yearly Average	32.0	41.3

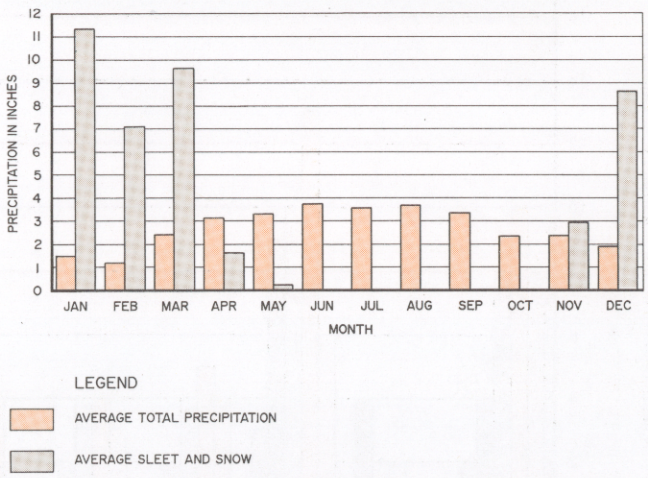
[a] *Data based on the period 1940 to 1987.*

[b] *Data based on the period 1930 to 1987.*

Source: National Climatic Data Center, Wisconsin Statistical Reporting Service, and SEWRPC.

Figure 30

PRECIPITATION CHARACTERISTICS
AT THE CITY OF WAUKESHA: 1940-1987



Source: National Climatic Data Center, Wisconsin Statistical Reporting Service, and SEWRPC.

results in frequent weather changes superimposed on the aforementioned annual range in weather characteristics, especially in winter and spring.

Prevailing winds in the County are northwesterly in the late fall and winter, northeasterly in the spring, and southwesterly in the summer and early fall. Wind velocities are less than five miles per hour (mph) for about 15 percent of the year, between five and 15 mph for about 60 percent of the year, and more than 15 mph for about 25 percent of the year.

AIR QUALITY

Air quality is an important determinant of the quality of life in Waukesha County and has important direct and indirect effects on the local economy. Air generally contains substances in the form of smoke, soot, dust, fly ash, fumes, mists, odors, and pollens. Although some of these pollutants in air have natural sources, much is contributed by such man-made sources as land cultivation, heat and power generation, industrial processes, transportation movements, and waste burning. Urbanization tends to intensify the contribution of air pollutants from human activities because the distribution of pollutant sources is less dispersed and, rather, more concentrated. When the level of pollutants in the air becomes so severe as to seriously and adversely affect health and property, an air quality problem exists.

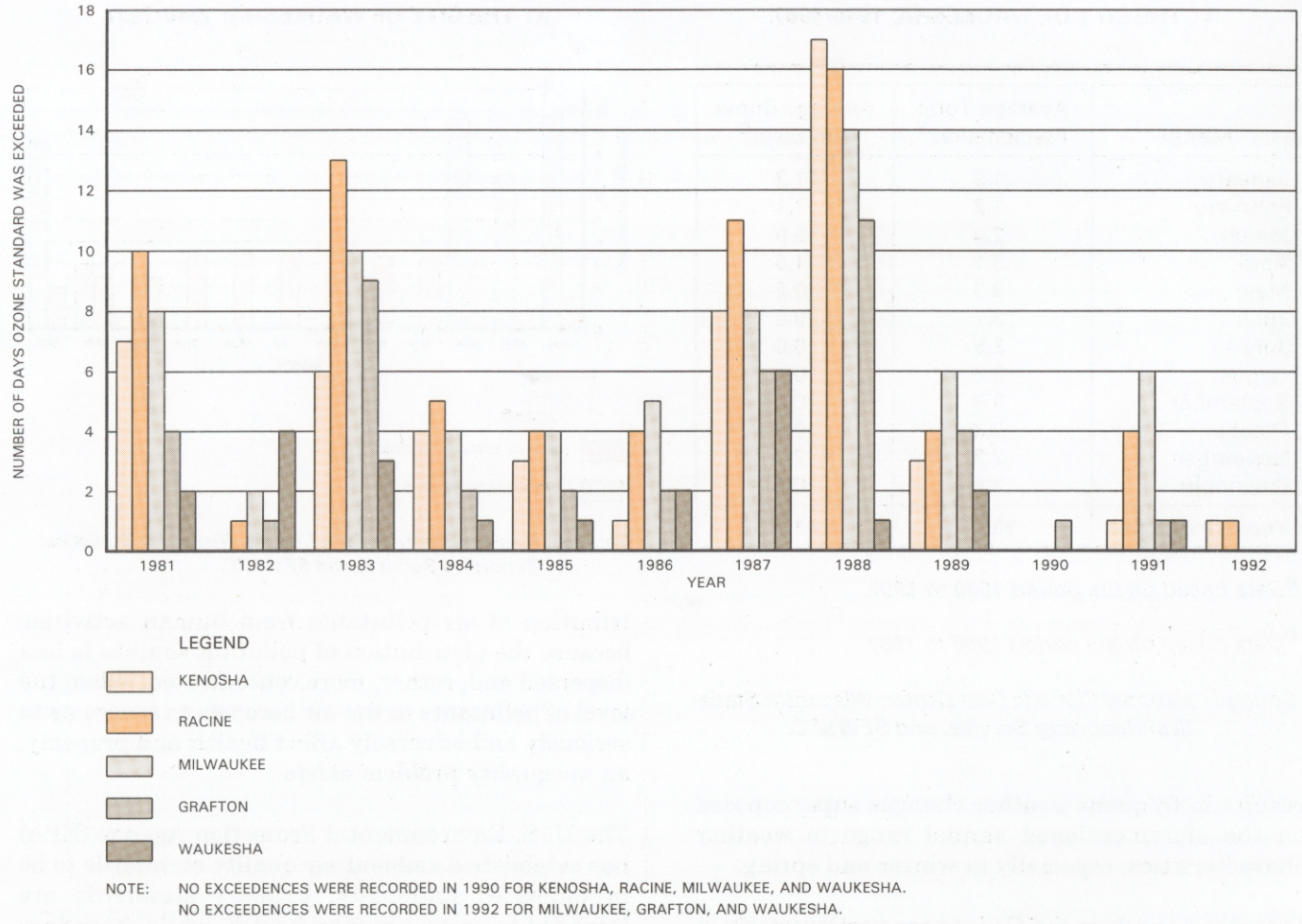
The U. S. Environmental Protection Agency (EPA) has established ambient air quality standards to be promulgated nationally. Primary standards are intended to protect human health, while secondary standards are aimed at protecting the public welfare by preventing damage to vegetation and real and personal property and at improving visibility. These standards, revised in the Clean Air Act Amendments of 1990, have been set for pollutants including particulate matter, sulfur dioxide, carbon monoxide, nitrogen oxides, ozone, and lead. On the basis of these standards, nonattainment areas, areas with ambient air quality conditions which do not meet the prescribed standards, have been identified. As a result, the Southeastern Wisconsin Region, and consequently all of Waukesha County, has been designated as an ozone nonattainment area. In addition, a portion of the City of Waukesha has been designated as a secondary nonattainment area for particulate matter.

Ozone

Ozone is referred to as a photochemical oxidant, a substance that, when subjected to certain conditions of heat and light, reacts chemically with other

Figure 31

FREQUENCY OF OZONE STANDARD EXCEEDANCES AT SELECTED MONITORING SITES IN THE SOUTHEASTERN WISCONSIN REGION: 1981-1992



NOTE: NO EXCEEDENCES WERE RECORDED IN 1990 FOR KENOSHA, RACINE, MILWAUKEE, AND WAUKESHA.
NO EXCEEDENCES WERE RECORDED IN 1992 FOR MILWAUKEE, GRAFTON, AND WAUKESHA.

Source: Wisconsin Department of Natural Resources and SEWRPC.

substances. In sufficient concentrations, ozone has been found to produce significant damage to the human respiratory system, to injure plants and animals, and to deteriorate materials in the man-made environment. Ozone is not emitted directly into the atmosphere, but is formed through a photochemical process involving volatile organic compounds, nitrogen oxides, and other air pollutants. Because a significant amount of these components originate from outside the Region, ozone is the most pervasive and troublesome of all air pollution components affecting ambient air quality in Southeastern Wisconsin. Precursor[1] emission sources in the greater Chicago area approximately 100 miles to the southeast contribute substantially to elevated ozone levels in Southeastern Wisconsin, especially on summer days with southerly winds.

EPA primary and secondary one-hour average ambient air quality standards, both set at 0.125 parts per million (ppm), are not to be exceeded more than once per year, averaged over a consecutive three-year period. Within Waukesha County, ozone levels are measured at Carroll College in the City of Waukesha. Figure 31 shows the frequency of ozone standard exceedence at sites throughout the Region, and indicates that the Waukesha site has consistently measured relatively low maximum hourly ozone levels, but still has not met the EPA standard for ozone. The number of exceedence days at each monitoring site, that is, the number of days having a peak one-hour average ozone concentration exceeding the standard of 0.125 ppm, is indicated in Table 31.

[1]*Precursor emissions are substances which precede the formation of ozone and are emitted at the source of pollution. They are transported to Southeastern Wisconsin by winds, where they contribute to the formation of ozone.*

Table 31

MONITORED OZONE LEVELS IN THE SOUTHEASTERN WISCONSIN REGION: 1987-1992

Monitoring Site	Year											
	1987		1988		1989		1990		1991		1992	
	Maximum Hourly Ozone Level[a] (ppm)	Number of Exceedence Days	Maximum Hourly Ozone Level[a] (ppm)	Number of Exceedence Days	Maximum Hourly Ozone Level[a] (ppm)	Number of Exceedence Days	Maximum Hourly Ozone Level[a] (ppm)	Number of Exceedence Days	Maximum Hourly Ozone Level[a] (ppm)	Number of Exceedence Days	Maximum Hourly Ozone Level[a] (ppm)	Number of Exceedence Days
Chiwaukee 11838 First Court Pleasant Prairie	--	--	0.222	18	0.176	4	0.120	0	0.170	10	0.179	2
Barbershop Quartet Society 7944 Sheridan Road Kenosha	0.219	8	0.192	17	0.170	3	0.106	0	0.129	1	0.150	1
Bayside Site 601 E. Ellsworth Lane Bayside	0.234	9	0.190	14	0.151	5	0.130	2	0.189	10	0.110	0
Alverno College 3401 S. 39th Street Milwaukee	0.187	4	0.146	1	0.141	1	0.124	0	0.149	2	0.103	0
Appleton Avenue 7528 W. Appleton Avenue Milwaukee	0.165	4	0.181	2	0.101	0	0.124	0	0.129	1	0.092	0
University of Wisconsin-Milwaukee 2114 E. Kenwood Boulevard Milwaukee	0.229	8	0.211	14	0.151	6	0.119	0	0.174	6	0.110	0
Blakewood School 3501 Blakewood Avenue South Milwaukee	0.202	7	0.177	9	0.141	2	0.125	1	0.166	5	0.114	0
Grafton High School 1950 Washington Street Grafton	0.230	6	0.198	11	0.156	4	0.133	1	0.146	1	0.104	0
Racine Department of Air Pollution Control 1521 Washington Street Racine	0.192	11	0.200	16	0.174	4	0.113	0	0.162	4	0.156	1
Lake Geneva Site RR 4 Elgin Club Road Lake Geneva	0.104	0	0.130	3	0.131	1	0.111	0	0.130	1	0.120	0
Slinger Village Hall 220 Slinger Road Slinger	0.163	4	0.121	0	0.141	1	0.106	0	0.105	0	0.106	0
Carroll College 225 N. Grand Avenue Waukesha	0.161	6	0.132	1	0.136	2	0.104	0	0.125	1	0.117	0

[a]*Primary and secondary one-hour average ozone ambient air quality standard equals 0.125 ppm.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

The ozone nonattainment area in which Waukesha County is located extends around the Lake Michigan shoreline from northern Indiana through the Chicago area to Door County, Wisconsin. The Federal Clean Air Act Amendments of 1990 require an acceleration of efforts to address ozone problems within nonattainment areas. Under the Amendments, nonattainment areas are classified into one of five categories: marginal, moderate, serious, severe, and extreme, depending on the severity of the problem. Within the Southeastern Wisconsin Region, the Counties of Kenosha, Milwaukee, Ozaukee, Racine, Washington, and Waukesha fall into the "severe" classification, and Walworth County falls into the "moderate" classification. The 1990 Clean Air Act Amendments establish the year 2007 as the date by which the ozone standards are to be attained.

One of the most important implications of the ozone nonattainment designation is that new industries which emit 25 tons per year or more of volatile organic compounds or nitrogen oxides are required to provide a reduction that entails a greater than one-for-one offset to such emissions from other sources in the vicinity. Such offset is intended to reduce overall pollutant emissions so the Region will eventually meet ambient air quality standards. This policy will discourage some industries from locating in the County. Land development in Waukesha County may also be impacted by such transportation control measures as the Federally mandated employee commute options program to reduce commuting by single occupancy vehicles and attendant vehicle miles of travel and pollutant emissions.

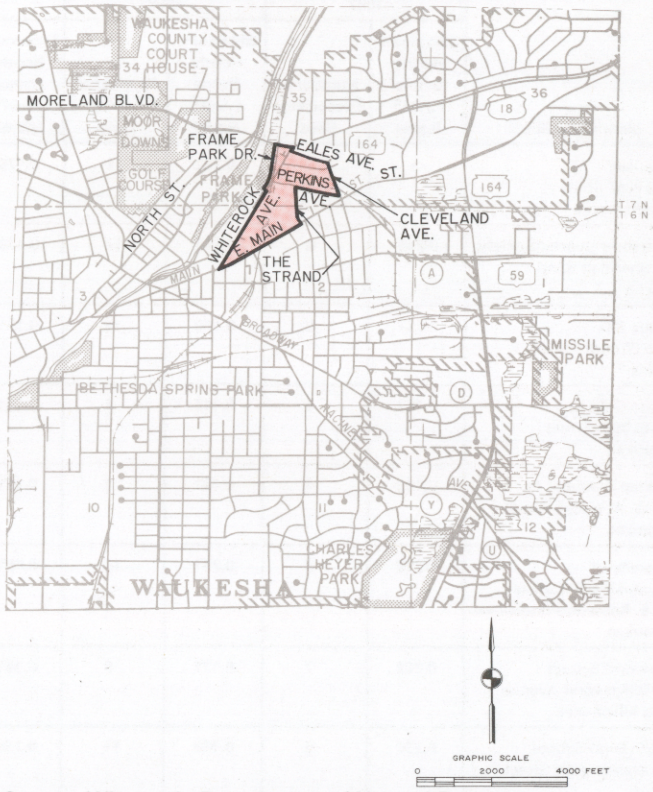
Particulate Matter

In 1978, the EPA designated a portion of Waukesha County as a secondary nonattainment area for particulate matter, on the basis of exceedences of the secondary standard[2] for total suspended particulate matter (TSP) monitored by the Wisconsin Department of Natural Resources (DNR). The area so designated is located in the central area of the City of Waukesha and is shown on Map 7. Nonattainment areas for particulate matter are generally characterized by multiple sources of the pollution, thus requiring relatively long-term and multifaceted abatement measures.

In the mid-1980s, the DNR initiated a special study to examine local air quality problems associated with quarrying operations in the vicinity of the Village of Sussex. It was determined that the State and Federal standards for particulate matter had been exceeded in the study area. However, the EPA was no longer active in designating nonattainment areas in Wisconsin, delegating such designation to the State. The study area did not contain multiple sources of pollution, existing regulations could be applied to solve the problem; thus description of the area as a nonattainment area was not warranted.

Map 7

MONITORED TOTAL SUSPENDED PARTICULATE MATTER LEVELS IN WAUKESHA COUNTY: 1988 AND 1991



Source: Wisconsin Department of Natural Resources.

The DNR operates 8 TSP sampling stations in the County; the results of monitored TSP matter levels at these stations are shown for the years 1988 and 1991 in Table 32. As indicated in Table 32, a number of these sites had exceedences of the secondary TSP standard in 1988. The DNR attributed the relatively large number of exceedences in the City of Waukesha, 19 in 1988, principally to foundry operations, and to quarrying operations near Sussex. Other conditions and activities in the vicinity of the quarries near Sussex that may have contributed to excessive TSP levels in 1988 include construction on STH 164, expansion of the Quad/Graphics plant in Sussex, and residential construction in new subdivisions near the quarries.

Exceedences in 1991 were far less numerous than in 1988, with the reductions attributable in part to favorable weather conditions and in part to air pollutant emission reductions. Since 1988, the former General Castings foundry facility was abandoned and the site cleared for redevelopment, the neighboring Tews concrete plant implemented dust-control measures at its facility, the neighboring

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[2]*Until 1987, Federal standards were expressed in terms of total suspended particulates, or TSP. In 1987, the U. S. Environmental Protection Agency replaced the TSP standards with standards for particulates less than 10 microns in size, the PM_{10} standards. The State of Wisconsin, while adopting the Federal PM_{10} standards, has retained the secondary TSP standard.*

Table 32

MONITORED TOTAL SUSPENDED PARTICULATE MATTER LEVELS IN WAUKESHA COUNTY: 1988 AND 1991

Monitoring Site	Year			
	1988		1991	
	Annual Geometric Mean ($\mu g/m^3$)[a]	Number of Exceedence Days	Annual Geometric Mean ($\mu g/m^3$)[a]	Number of Exceedence Days
1335 Cleveland Court, Waukesha	64	9	50	1
1238 The Strand, Waukesha	60	19	49	1
1344 White Rock Avenue, Waukesha	50	4	39	0
100 Bank Street, Waukesha	49	2	37	0
W239 N53 Highway K, Sussex	46	9	35	1
W224 N5045 Eastview Drive, Sussex	44	2	34	0
W227 N5978 Avon Court, Sussex	42	6	34	2
W249 N6424 Highway J, Sussex	40	1	37	0

[a] *$\mu g/m^3$ denotes micrograms per cubic meter.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Navistar foundry installed air pollution control equipment at its facility, and the City of Waukesha agreed to increase street cleaning activity in the area. The Halquist Stone Company and the Vulcan Materials Company, operators of quarries near Sussex, have also implemented air quality improvement measures since 1987.

GEOLOGY AND PHYSIOGRAPHY

Surface Geology and Physiography

The physiographic features, or surface landforms, of Southeastern Wisconsin are shown on Map 8. Four major stages of glaciation, the last of which was the Wisconsin stage, ending approximately 10,000 years ago in the State, have largely determined the physiography, topography, and soils of the Region, including Waukesha County. The dominant physiographic and topographic feature in Waukesha County is the Kettle Moraine, an interlobate glacial deposit formed between the Green Bay and Lake Michigan lobes of the continental glacier which moved in a generally southerly direction from its origin in what is now Canada. As indicated on Map 8, the remainder of the County is covered by a variety of glacial landforms and features, including various types of moraines, drumlins, kames, outwash plains, and lake basin deposits.

End moraines, formed by deposition at the margin of a glacier at a time when melting equaled the rate of advance, consist of unsorted debris ranging from clay to boulders. End moraine topography typically consists of a ridge with a rolling surface, often with internal drainage. Ground moraines were formed beneath glacial ice during its advance or retreat. Such moraines were deposited as a blanket of unsorted rock debris of irregular thickness, ranging from clay to boulders, and may have been buried by later glacial deposits. Ground moraines usually have moderate relief and form a gently undulating plain with no definite alignment to the undulation. In some areas, however, elongated hills of ground moraine, or drumlins, are aligned along the direction of ice movement.

Outwash plains are stratified deposits consisting of gravel, sand, silt, and clay, laid down by water from melting ice fronts. Buried outwash deposits from earlier glaciation are apparent from well drilling records, but difficult to map accurately. Lake-basin deposits are composed of materials derived from glaciers and later deposited in freshwater lakes.

The Kettle Moraine, which is oriented in a general northeast-southwest direction across western Washington, Waukesha, and Walworth Counties, is a complex system of kames, or crudely stratified conical hills; kettle holes formed by glacial ice blocks that became separated from the ice mass and melted to form depressions and small lakes as the meltwater deposited material around the ice blocks; and eskers, long, narrow ridges of drift deposited in abandoned drainageways.